

# HamSCI Personal Space Weather Station: Overview and Project Update

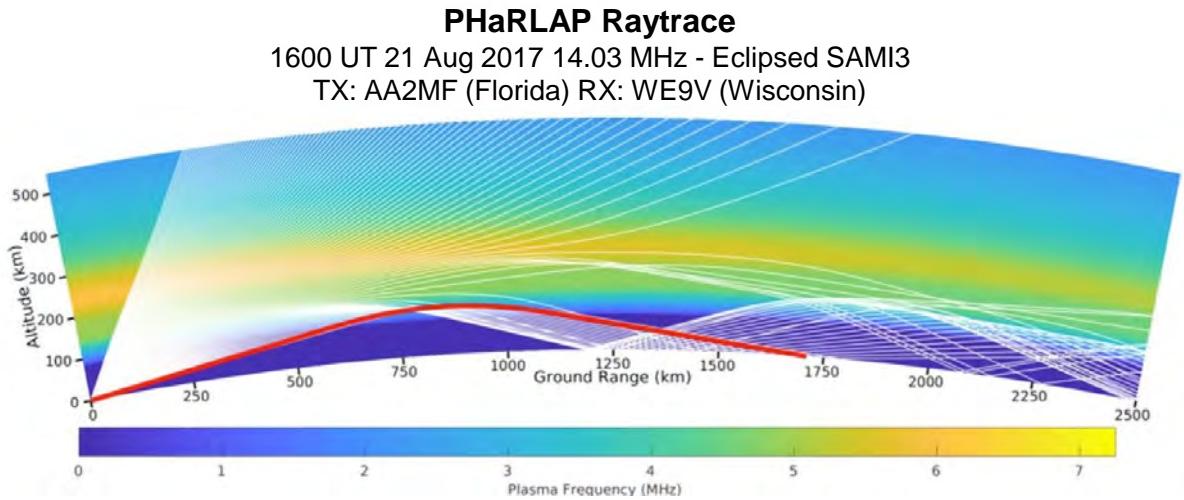
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Nathaniel A. Frissell W2NAF<sup>1</sup>

<sup>1</sup>The University of Scranton

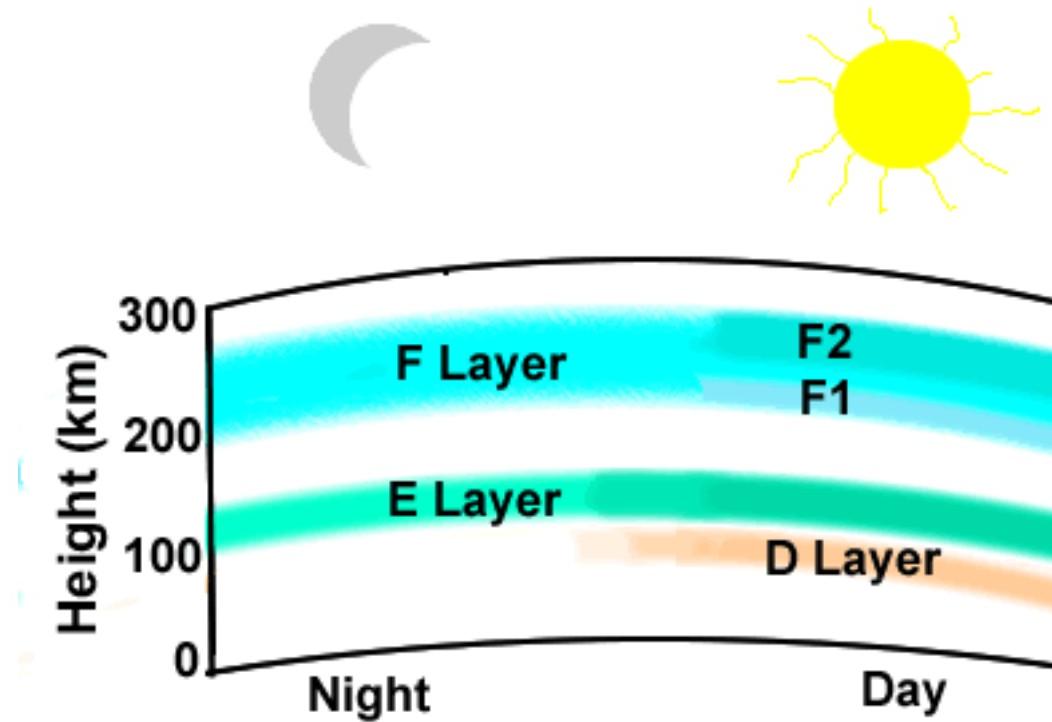
# Ham Radio Frequencies and Modes

	Frequency	Wavelength
LF	135 kHz	2,200 m
MF	473 kHz	630 m
	1.8 MHz	160 m
HF	3.5 MHz	80 m
	7 MHz	40 m
	10 MHz	30 m
	14 MHz	20 m
	18 MHz	17 m
	21 MHz	15 m
	24 MHz	12 m
	28 MHz	10 m
VHF+	50 MHz	6 m
And more...		



- Hams routinely use HF-VHF transionospheric links.
- Often ~100 W into dipole antennas.
- Common HF Modes
  - Digital: FT8, PSK31, WSPRNet, RTTY
  - Morse Code / Continuous Wave (CW)
  - Phone: Single Side Band (SSB)

# The Ionosphere

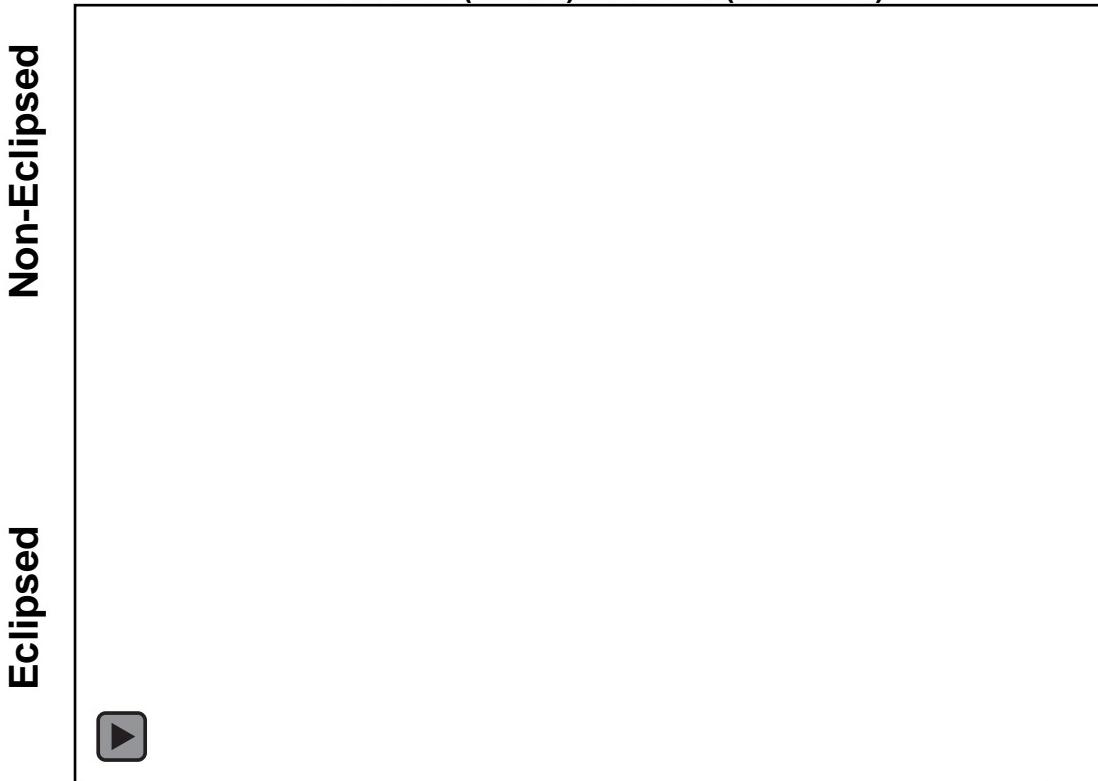


<https://commons.wikimedia.org/wiki/File:IonosphereLayers-NPS.gif>

# SAMI3-PHaRLAP Raytrace

1600–2200 UT 14.03 MHz

TX: AA2MF (Florida) RX: WE9V (Wisconsin)



# Ham Radio Observation Networks

main page - Reverse Beacon Network

reversebeacon.net/main.php

## REVERSE BEACON NETWORK

welcome | main | dx spots | nodes | downloads | about | contact us

Check out RBN's blog at: <http://reversebeacon.blogspot.com>, stay tuned!

Check out your signal compared to others, with the "Spot Analysis Tool".

You can compare signals between up to 10 stations heard by a single reverse beacon on a given date.

[Donate](#)

Map | Satellite

Map Data (2017) | Terms of Use

options:  
show/hide

news  
RBN blog: stay tuned!

we have 142 skimmers online

skimmers online:

- 385CW - 20m
- 3L4LU - no spot last 15min
- 3M2CQ - 20m
- 4A3C - 20m
- AAVAV - 40m, 20m, 17m
- ADOC - no spot last 15min
- AE4W - 40m, 20m, 17m
- BG4ARE - 20m
- BG5NUO - 30m, 20m
- BH4KU - 40m, 20m, 15min
- DF4UE - 80m, 40m, 30m, 20m
- F7 - 17m
- FO4KK - 40m, 20m
- DZ4AK - no spot last 15min
- DWE - 40m, 30m, 20m, 17m
- DK3LA - 40m, 30m
- DK5NE - 6m
- DK7RR - 30m, 20m
- DL3GR - 40m, 20m
- DL4RDX - 20m
- DL4TJ - 20m
- DL6LAS - 40m, 30m, 20m
- DL6GTB - 80m, 40m, 30m
- DL6GTB - 80m, 40m, 30m
- DO4DXA - 80m, 40m, 20m, 15m
- EW4AR - 40m, 30m, 20m
- EW4W - 17m, 15m
- EW4VQ - no spot last 15min

# Reverse Beacon Network (RBN)

*reversebeacon.net*

- Quasi-Global
  - Organic/Community Run
  - Unique & Quasi-random geospatial sampling

The screenshot shows the WSPrnet website interface. At the top, there's a navigation bar with links for 'Map | WSPrnet', 'Not Secure', 'wsprnet.org/drupal/wsprnet/map', and a user account section. Below the header is a large, stylized 'WSPrnet' logo. The main content area has a sub-header 'Welcome to the Weak Signal Propagation Reporter Network'. On the left, there's a sidebar for 'User login' with fields for 'Username' and 'Password', and links for 'Create new account' and 'Forgot your password?'. Below the login is a section for 'Frequencies' with a table of data. Further down is a 'Spot chart' showing activity over the last hour. The right side of the page features a world map where various amateur radio stations are plotted as colored dots, with labels like 'ALPO', 'COSTA RICA', 'HONDURAS', 'MEXICO', 'CARIBBEAN', 'AFRICA', and 'LATIN AMERICA'. A legend at the bottom right indicates station types: 'DX', 'VHF', 'UHF', 'SHF', 'EHF', and 'Other'.

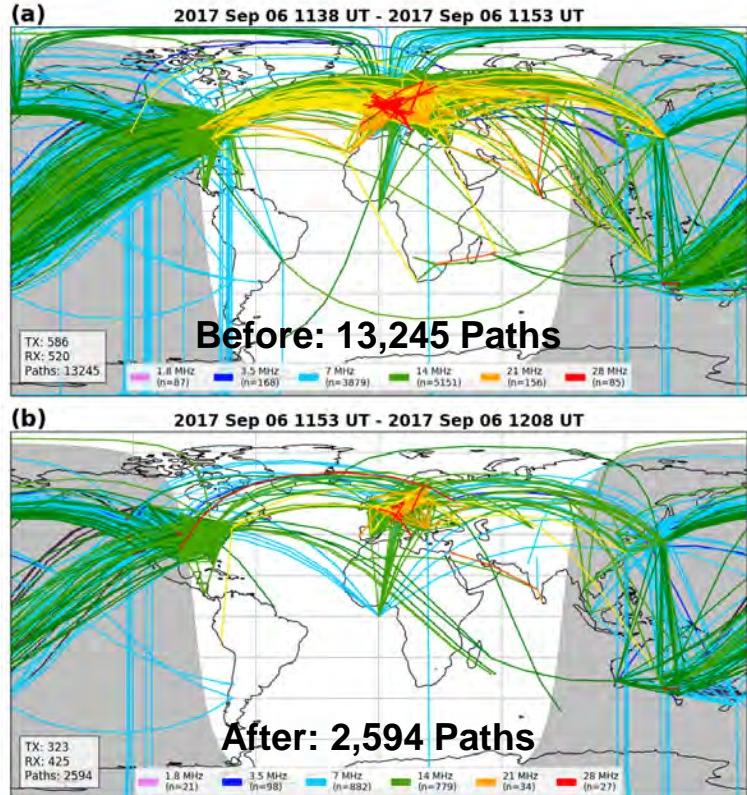
**WSPRNet**  
*wsprnet.org*

- Data back to 2008 (A whole Solar Cycle!)
  - Available in real-time!

Monitor: WADWHE Loc EN16pu  
in United States  
Receiving: PSK31 JTF65 on 14.070 MHz (20m)  
Using: Digital Master V8.6 4.0.647/RxR V0.6  
Antenna: 1/2 wave vertical (comHeP) 80-10m QCC dipole or Comtek 40m ver  
Show all news by WADWHE

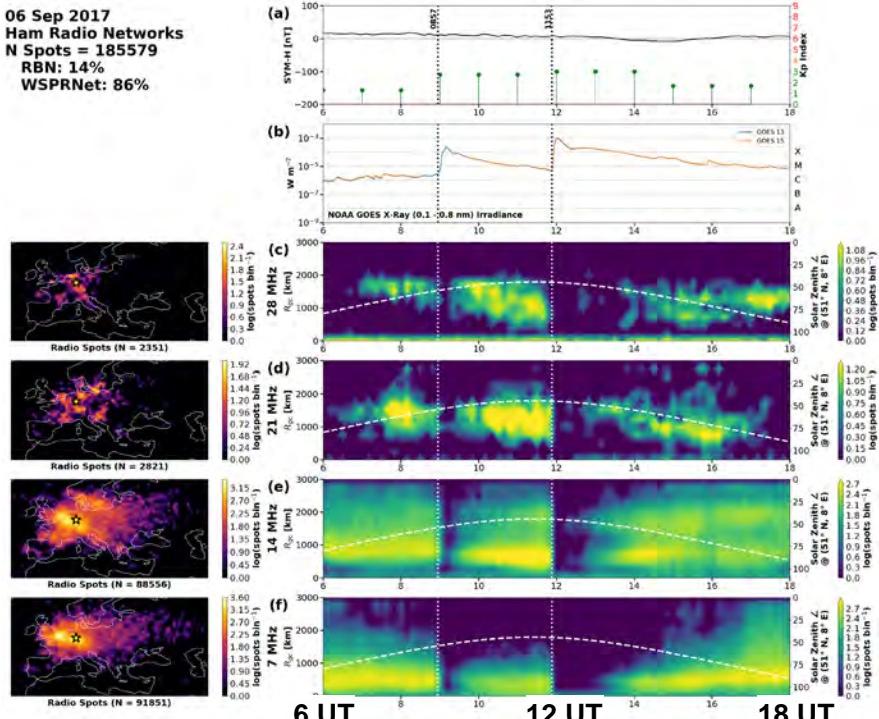
**PSKReporter**  
*pskreporter.info*

# Ham Radio HF Response to Solar Flares



06 Sep 2017  
Ham Radio Networks  
N Spots = 185579  
RBN: 14%  
WSPRNet: 86%

6 Sept  
2017  
1153 UT  
X9.3  
Flare

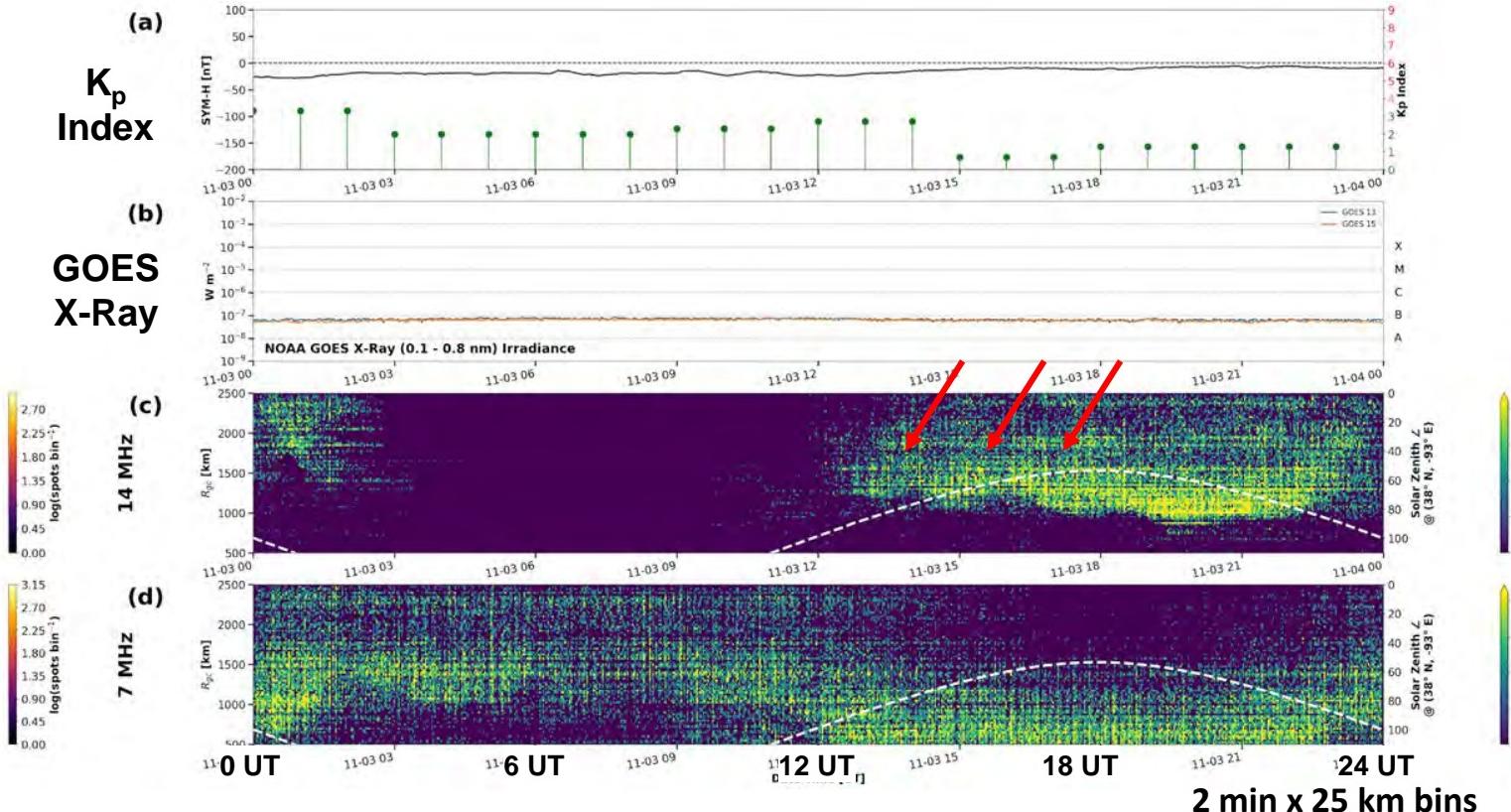
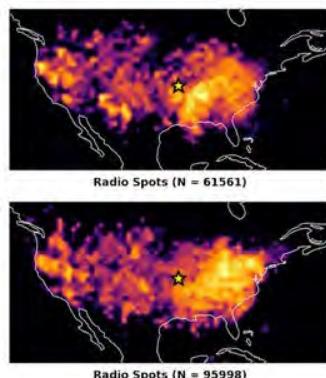


(Frissell et al., 2019, <https://doi.org/10.1029/2018SW002008>)

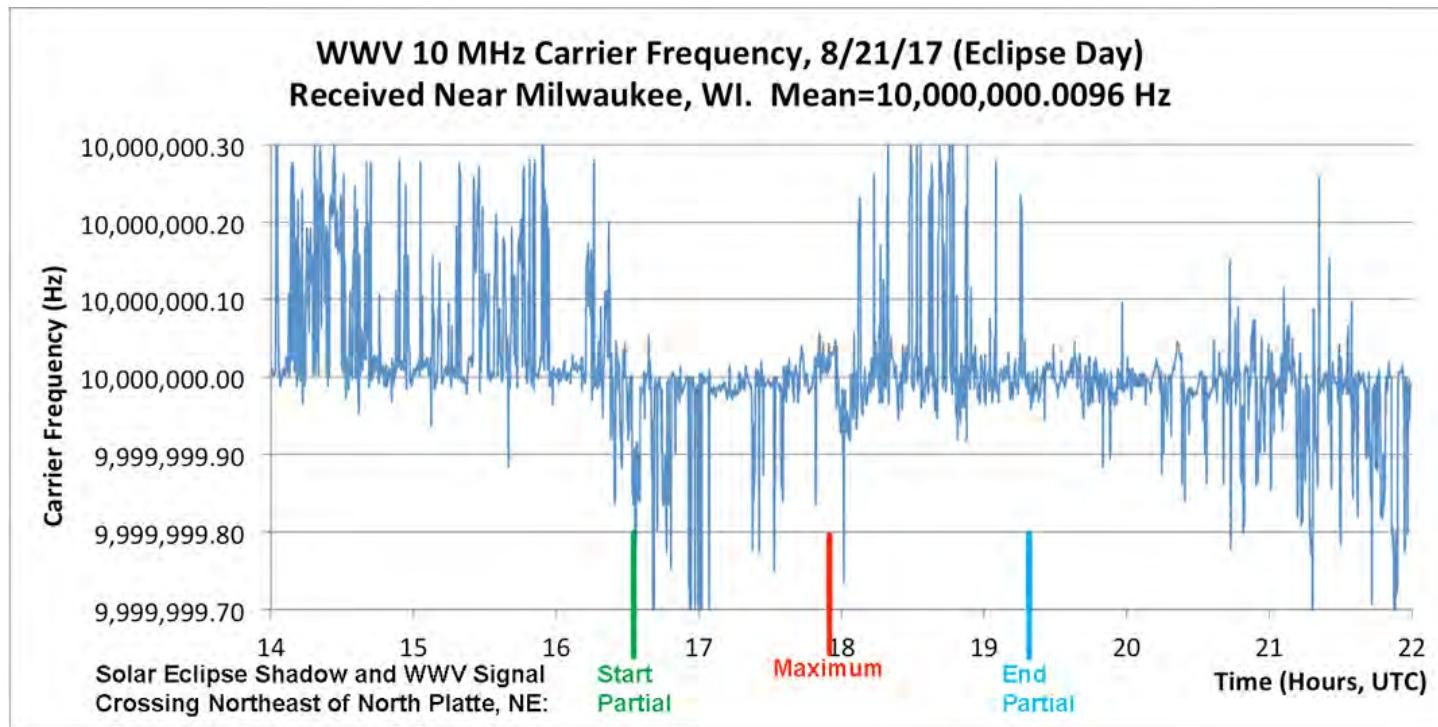
## **Ham Radio View of Traveling Ionospheric Disturbances**

**N Spots = 157559**  
**RBN: 29%**  
**WSPRNet: 71%**

3 Nov 2017



# WWV/CHU Standards Monitor



Steve Reyer, WA9VNJ

# Can we do better?

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- This is all great, but ham radio receiver networks weren't designed for science.
- What if we could create a network of Personal Space Weather Stations that were designed for both science (and ham radio!) from the ground up?
- That is the idea behind the HamSCI Personal Space Weather Station project.

# Personal Terrestrial WX Station

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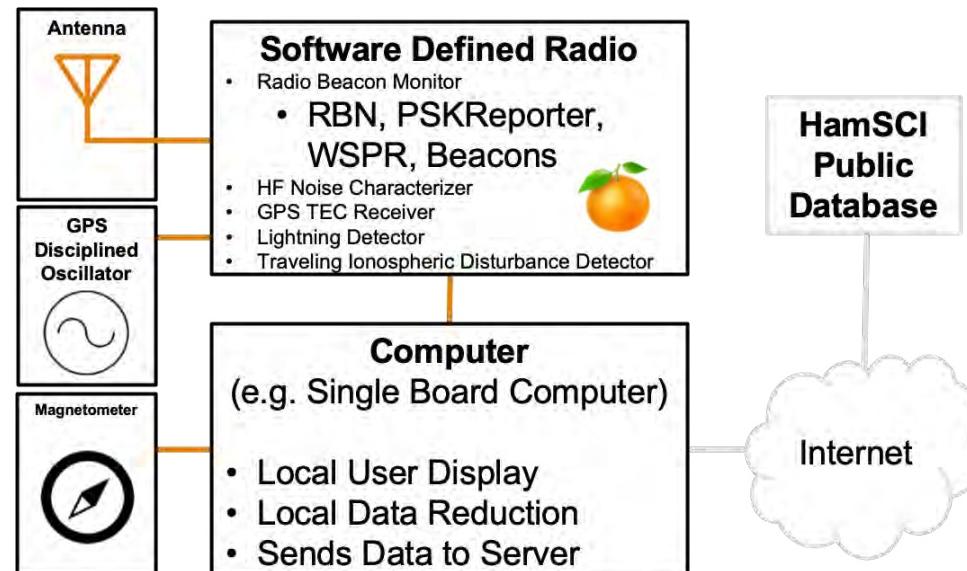
- Multi-instrument
- Internet Connected
- Easy Set-Up
- Reasonable Cost



Ambient Weather WS-2902

# Personal Space Weather Station

- Useful to ham radio, space science, and space weather communities.
- Modular Instrument Design
  - Easy ability to add or remove instruments, especially in software architecture
- Small footprint
- Nice User Interface/Local Display
- Standard format to send data back to a central repository
- Open community-driven design

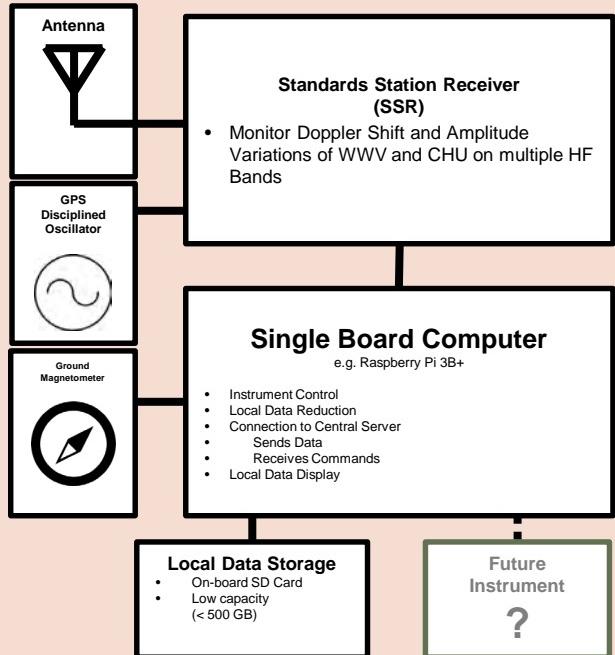


<http://hamsci.org/psws>

# Personal Space Weather Station

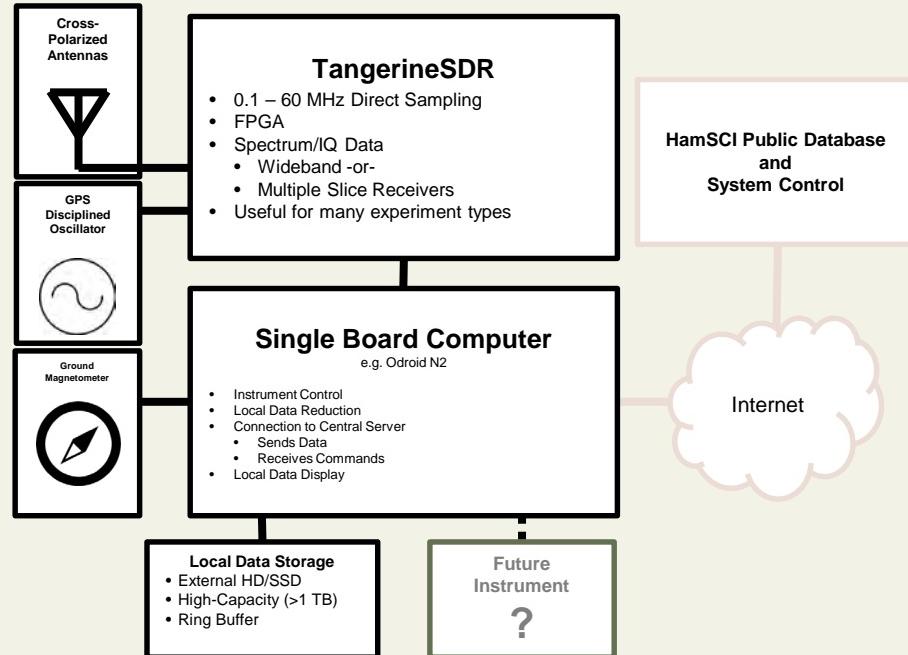
(a)

## Low-Cost PSWS



(b)

## SDR-Based PSWS



# PSWS Teams



## University of Scranton

- Nathaniel Frissell W2NAF (PI)
- Dev Joshi (Post-Doc)

## Responsibilities

- Lead Institution
- HamSCI Lead
- Radio Science Lead



## TAPR & Zephyr Engineering

- Scotty Cowling WA2DFI (Chief Architect)
- Tom McDermott (RF Board)
- John Ackerman N8UR (Clock Module)
- David Witten KD0EAG (Magnetometer)
- David Larsen KV0S (Website)

## Responsibilities

- TangerineSDR (High Performance)
- Data Engine
- Ground Magnetometer



## University of Alabama

- Bill Engelke AB4EJ (Chief Architect)
- Travis Atkison (PI)

## Responsibilities

- Central Database
- Central Control Software
- Local Control Software



## MIT Haystack Observatory

- Phil Erickson W1PJE

## Responsibilities

- Science Collaborator

HamSCI



## Case Western Reserve University

## Case Amateur Radio Club W8EDU

- Soumyajit Mandal (PI)
- Kristina Collins KD8OXT
- John Gibbons N8OBJ
- Rob Wiesler AC8YV
- David Kazdan AD8Y (Co-Lead)
- Matt McConnell KC8AWM
- Skylar Dannhoff KD9JPX
- Aidan Montare KB3UMD

## Responsibilities

- Low Cost PSWS System

## New Jersey Institute of Technology

- Hyomin Kim KD2MCR (PI)
- Gareth Perry KD2SAK
- Andy Gerrard KD2MCQ

## Responsibilities

- Ground Mag Oversight & Testing
- Science Collaborators

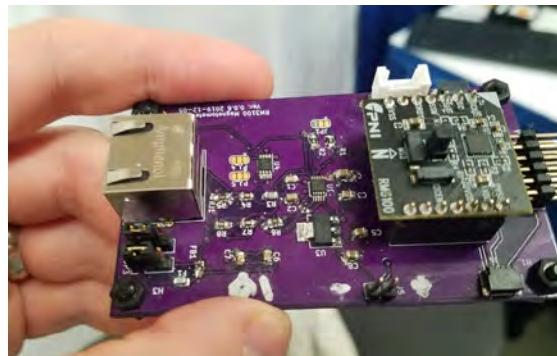
# Current Progress

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- We are well on our way!
- Where can I see the latest?
  - TangerineSDR Website –  
<https://tangerinesdr.com/>
  - Specification Documents
  - Listserv
  - Monday Night Telecons
  - Mockup of TangerineSDR
- For the rest of this morning, we will hear project updates from the individual PSWS Teams.



Scotty WA2DFI explaining the TangerineSDR board mockup  
<https://youtu.be/81MlplpB7Mo>



David KD0EAG showing magnetometer prototype at 2020 HamCation in Orlando, FL

# Thank you!

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